THE STUDY OF FRICTION COEFFICIENT, BRAKE PADS TEMPERATURE AND ADDHESIVE RESISTANCE ON BRAKE PADS USING FLY ASH COAL

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ABSTRACT

Abstract:

Brake pads are one component of a motor vehicle which is used to slow or stop the vehicle. When at high-speed vehicle brake has a very important role. The purpose of this study was to investigate the influence of the environment in the form of spraying with water, sea water, and oil to the friction coefficient of the brake pads and investigate adhesion resistance resulting of a break from the manufacture of brake pads Fly Ash compared with Honda Genuine Parts brake.

This research was conducted by mixing ingredients brake pads according to a predetermined composition, press the brake pads with a load of 3 tons for 30 minutes, then heated to a temperature of 120 ^{0}C for 30 minutes. The method is performed in testing the friction coefficient is based on the standard ASTM C1028. To determine the value of the resistance of glue or adhesive shear loads due to the brake pads using the ASTM D3737 standard, in place on the die according to ASTM standard D905. Analysis is conducted after got data of testing result.

The results showed that the friction coefficient brake Honda Genuine Parts at 0.64μ while the friction coefficient brake Fly Ash of 0.60μ. But the brake condition given spraying water, sea water, and oil brake Fly Ash is better than Honda Genuine Parts. From the test results and the calculation of shear strength indicates that the brake pads Fly Ash not better than the Honda Genuine Parts brake. This is evidenced from the results of testing the shear strength of Honda Genuine Parts brake at 3.552×10^6 (N/m^2) while the brake Fly Ash at 2.471×10^6 (N/m^2).

Key words: *Brake pads, fly ash coal, friction coefficient*

Background

The developments of technology in various fields are very rapidly, especially in the automotive fields. With the development of vehicle performance, it is necessary to get an effective braking system and also the safety in vehicles.

The use of asbestos in the manufacturing of brake pads is not environmentally friendly, because it has a negative impact on health. As with previous studies of brake pads motorcycle can be made by utilizing waste fly ash coal as an amplifier and Epoxy Resin and Magnesium Oxide (MgO) as a matrix. Besides to environmentally friendly, fly ash also has advantages in terms of lower cost production than brake pads made of asbestos.

In this study, fly ash is selected as a material used to manufacture the brake pads, because Fly ash has good chemical properties of pozzolanic and physical properties of low porosity and fine particle.

Problem Statement

Problem statement that can be drawn from the problem above is how the effect of variations in the composition brake shoes made from flay ash coal, Magnesium Oxide (MgO), and epoxy resin.

Objectives

1. Investigate the use of fly ash coal as a substitute for asbestos in the manufacture of brake pads.
2. Investigate environmental factors of brake pad performance by spraying with water, sea water and oil.
3. Investigate the adhesive resistance of brake pads due to shear loads between brake pads connection and brake shoes using *Dexton Plastic Steel Epoxy* as connectivity material.

Literatures Review

Isak, Bukhori. A, (Final Project 2013), "*Analysis and manufacturing composite for brake shoes of motorcycle Honda supra x 125 cc using fly ash coal, and magnesium oxide with epoxy matrix".* From Brinell hardness test results generated that hardness resulting from brake shoes variation has a value of 6.4 BHN and brake shoes

variation 2 has a value of 14.8 BHN more great than brake shoes Honda Genuine Parts has a value of 12.3, while for Variation 3 has a value of 10.2 BHN and Variation 4 has value 8.9 BHN is smaller than Honda Genuine Parts brake shoes.

Tri, H.U (final project 2010), "*Pengaruh lingkungan terhadap keausan, daya, koefisien gesek, suhu kampas rem, dan waktu pengereman kampas rem berbahan fiberglass".* The results showed that the dry conditions, brake that uses glass fiber (fiberglass) 21.4% more wear resistant, spraying oil at 23.8% more resistant to wear, the brake fluid spraying over 29.4% of wear on the brake indopart, while the spraying conditions, water brake indopart 38% more resistant to wear and the condition of the sea water spraying 25% more wear resistant than the epoxy fiber brake lining. Hardness value is equal 20.4HB fiber epoxy.

Basic Theory

Particulate Composites

Particulate composites using a composite powder particles as reinforcements and evenly distributed in its metric.

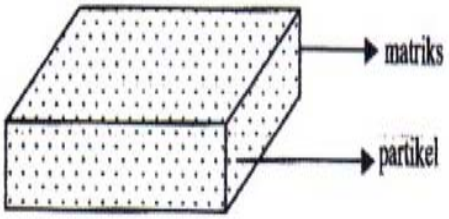


Figure 2. Particulate Composite

Sintering

Sintering is a method of making the material of powder by heating the particles to form a bond. Sintering is the bonding together of particles at high temperatures. Sintering can occur below the melting temperature (melting point).

During the sintering process of the merger will occur between the particles, so that each binding. In the sintering process, there will be a process of movement between powder particles on the surface of the powder. The most important equipment in the sintering process is sintering kitchen. This kitchen must be able to regulate the temperature, heating time, heating rate, and the environment in the kitchen itself.

Material Preparation

Fly Ash Coal

Fly ash is the fine particles that are precipitated from the burning pile of coal powder, the amount is quite large, so it requires a management that does not cause environmental problems such as air pollution, water and ecosystem degradation.

Figure 3. Fly Ash Coal

EPOXY RESIN

Epoxy is a thermoset polymer type, the plastic cannot be recycled. Epoxy resins are composed of two materials, namely epoxy resin and hardener or curing agent

Epoxy resins are thermosetting plastics including group, which is no longer melt when heated. The hardening occurs due to the polymerization reaction, not freezing. The system consists of two components of the resin and curing agent are mixed at the time will be used.

Figure 4. Epoxy Resin and Hardener

MgO (MAGNESIUM OXIDE)

MgO (Magnesium Oxide) is a material that is very lightweight metal structure, MgO chosen as a filling material that also serves as an abrasive and amplifier because it has good characteristics. In addition, magnesium oxide as a wetting agent that makes the bond between Alumina and Aluminum is strong, not easily eroded surface. Although a small percentage of MgO powder an important role because they have the ability to charge any difference in height of the rough surface and lower the interfacial tension. Wear resistance can be improved through the addition of elemental magnesium oxide.

Figure 5. Magnesium Oxide

Braking Shoes Plate

Brake shoe plate taken from used Brake pads that are not used.

Figure 6. Braking Shoes Plate

Dextone Epoxy and Hardener

Glue serves Dextone Epoxy and Hardener to attach the Brake pads material with brake shoes.

Figure 7 Dextone Epoxy and Hardener

Tools Preparation

Die

Where to print the brake lining material.

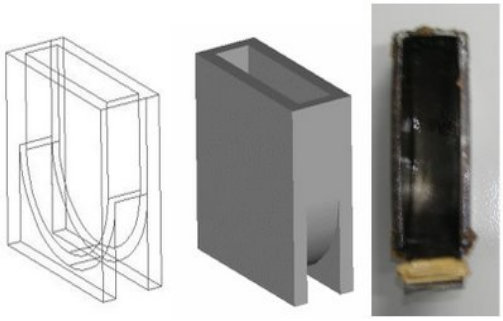


Figure 8 Die

Oven

Oven used in the sintering process. With capacity of temperatures 0 ^{0}C to 250 ^{0}C

Figure 9 Oven

Press Tool

Use to suppress the printing presses the brake with the precified pressure.

Figure 10 Press Tool

Non-contact Infrared Thermometer

Non-contact Infrared Thermometer is used to measure the temperature and the Brake pads, drum with a capacity of -50 0C to 500 0C.

Figure 11 Non-contact Infrared Thermometer

Vernier Caliper

Vernier Caliper is used to measure the height of the canvas on the brakes before and after the test.

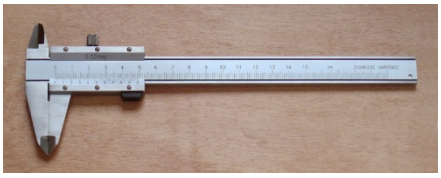


Figure 12 Vernier Caliper

Scales

Measure the mass of the load and the pendulum is used for testing the friction coefficient.

Figure 13 Scales

Friction coefficient

The friction coefficient is a scale that indicates the level of the surface roughness of an object when both objects were rubbing. Mathematically, the friction coefficient is defined as the ratio between the number results with the magnitude of the frictional force to normal force on an object. So the friction coefficient is determined by two factors, namely the level of roughness of the two fields of touch and the normal force acting on the object. The magnitude of the normal force acting on an object is proportional to the weight of the object, because the object only works contained gravity on its surface. So that mathematically, the magnitude of the normal force is equal to gravity.

$$N = w = (m.g)$$

The friction coefficient is symbolized by the Greek letter μ, which is a small-scale value-dimensional frictional force that explains the comparison between the two parts and both compressive forces.

Basic friction coefficient formula (μ):

$$\mu = \frac{F}{N}$$

Where:

F = Friction force (Newton)

N = Normal force (Newton)

Friction brakes on canvas influenced the amount of rounds it is necessary to find the torque produced. Moment T is absorbed by the brake drum, then:

$$T = f \times \left(\frac{\mathrm{D}}{2}\right)$$

Where:

T = Torque (kg.mm)

f = compressive force (kg)

D = Diameter drum (mm)

Glue Strength Testing

In this study, using the testing tools compression test. Testing the strength of the glue using standards ASTM D3737. ASTM D3737 method is to determine the value of vertical shear force carried out on the material layer attached to the glue. When testing the strength of the glue specimen (drum brake) in place on the die / mold that has been designed according to the standard ASTM D905. ASTM D905 is a reference to lock the brake when the shear strength testing.

Brake shear strength can be calculated by the formula:

$$\sigma = \frac{F}{A}$$

Where:

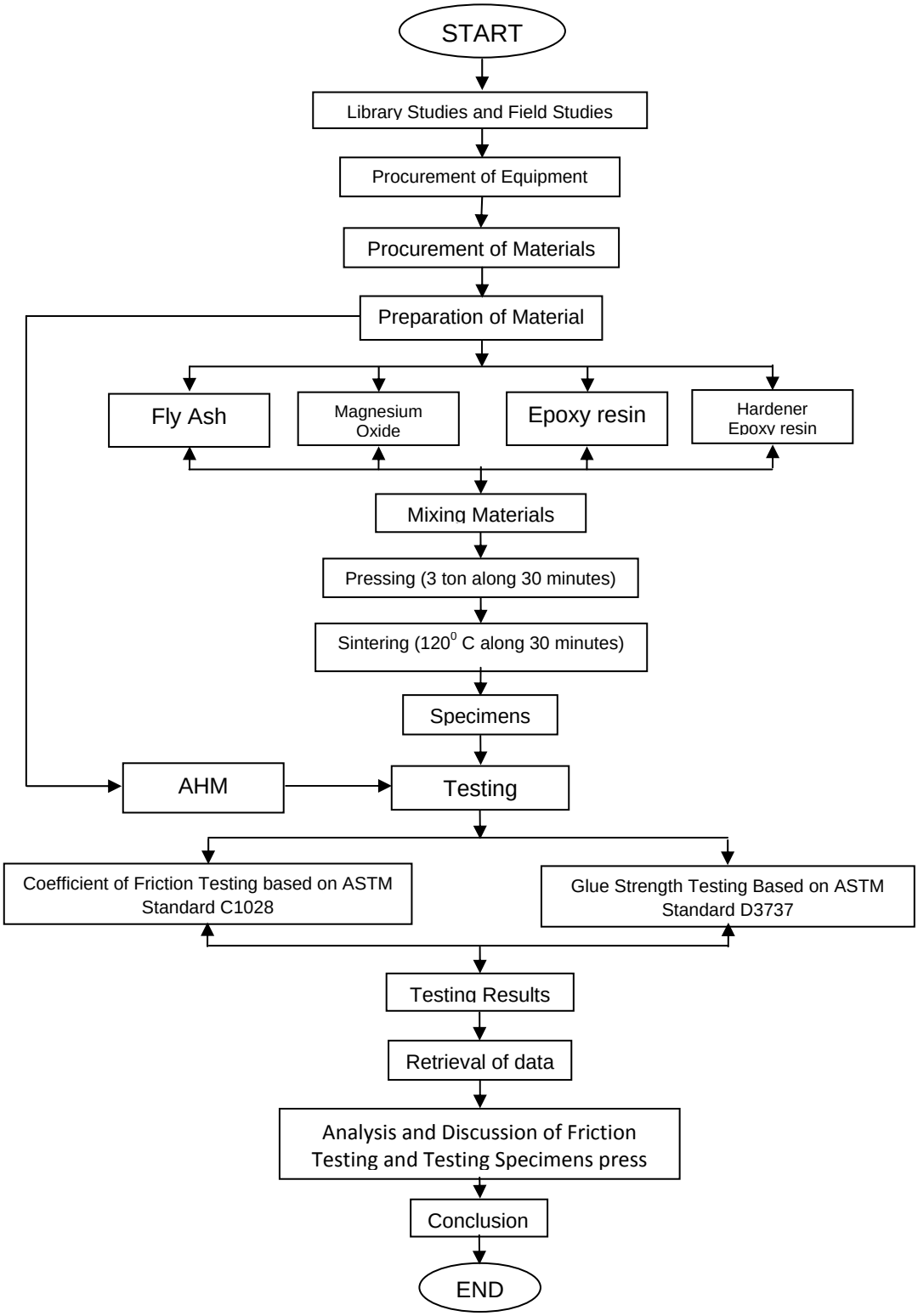
σ = The maximum shear strength in units (N/m^2)

F =The maximum compressive force to brake off (N)

A = brake sectional area (m^2)

METHODS

Flowchart of Research



Result of Testing Analysis

Results Calculations Friction Coefficient

In this experiment, the method is performed in the friction coefficient testing based on ASTM C1028. ASTM C1028 Standard sets out methods for testing the friction coefficient.

Table 1 The Results of Calculations of Friction Coefficient

No	Brake Pads	Friction Coefficient (μ)
1	Fly Ash	0.60
2	Fly Ash spraying water	0.50
3	Fly Ash spraying sea water	0.51
4	Fly Ash spraying oil	0.48
5	Honda Genuine Parts	0.64
6	Honda Genuine Parts spraying water	0.49
7	Honda Genuine Parts spraying sea water	0.50
8	Honda Genuine Parts spraying oil	0.50

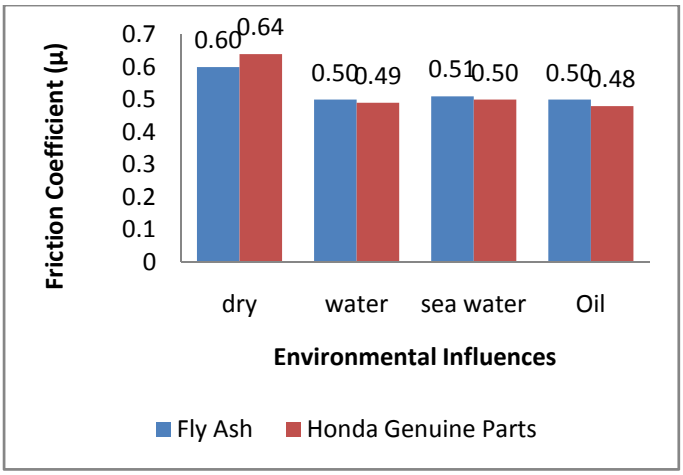


Figure 14 The Relationship between Graphs with has given a type Brake Pads Friction Coefficient Effect against Environmental.

From the results of the coefficient of friction brake pads, in dry conditions or without any effect spraying brake pads Honda Genuine Parts brake pads are better than the fly ash material. This proved from the value of the coefficient of friction brake pads Honda Genuine Parts at 0.64 while the coefficient of friction brake pads Fly Ash at 0.50.

But brake pads with spraying water and sea water, Fly Ash brake pads are better. This is proved from brake pad friction coefficient Fly Ash respectively in 0.50 and 0.51 waters spraying conditions and sea water spraying conditions, while the value of the coefficient of friction of the brake

pads Honda Genuine Parts in water sprays and sea water spray conditions amounting 0.49 and 0.50.

In conditions of spraying oil, brake pads Honda Genuine Parts brake pads are better than Fly Ash. It is shown from the value of the friction coefficient is equal to Honda Genuine Parts 0.50 in oil spraying conditions, while the value of the coefficient of friction brake pads Fly Ash at 0.48.

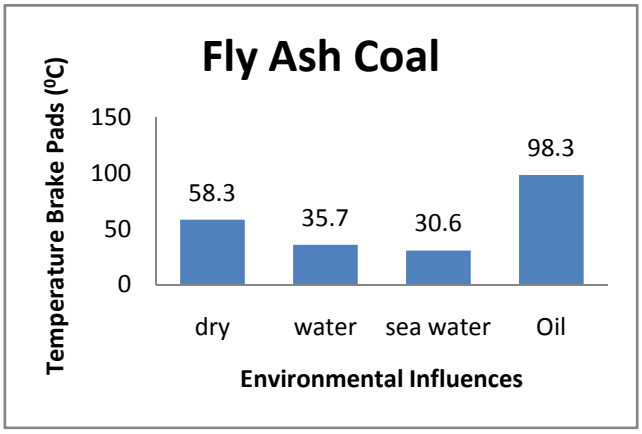


Figure 15 Relationship between Graphs with Given Brake Pads type Environmental Effect of Temperature Brake Pads.

The Results of Temperature brake pads

Table 2 The results of the study average brake pads

No	Brake Pads	Brake Pads Temperature (^{0}C)
1	Fly Ash	58.3
2	Fly Ash spraying water	35.7
3	Fly Ash spraying sea water	30.6
4	Fly Ash spraying oil	98.3
5	Honda Genuine Parts	74.9
6	Honda Genuine Parts spraying water	37.8
7	Honda Genuine Parts spraying sea water	41.5
8	Honda Genuine Parts spraying oil	73.3

From the experimental results of the final temperature of brake pads, overall brake pads Fly Ash is better. This is shown well in dry conditions, as well as wet conditions in water spraying conditions, sea water and oil. This is proved from brake pad temperature of 58.3 ^{0}C Fly Ash in dry conditions, 35.75 ^{0}C in water spraying conditions, 30.675 ^{0}C in seawater spraying conditions and 98.3 0C in oil spraying conditions.

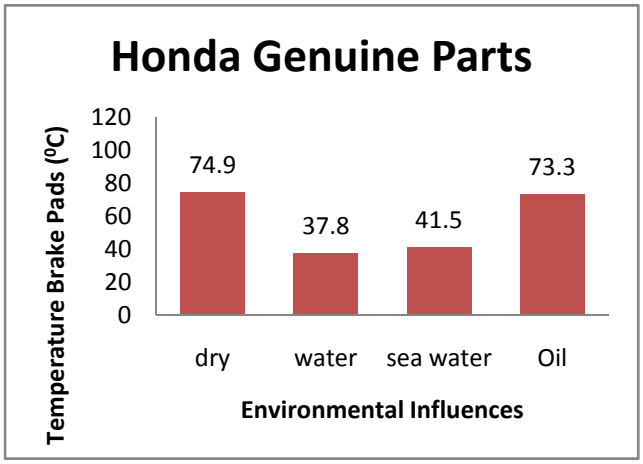


Figure 16 Relationship between Graphs with Given Brake Pads type Environmental Effect of Temperature Brake Pads.

From the experimental results of the final temperature of brake pads, overall brake pads Fly Ash is better. This is shown well in dry conditions, as well as wet conditions in water spraying conditions, sea water and oil. This is proved from brake pad temperature of brake pad temperature while Honda Genuine Parts at 74.9 ^{0}C in dry conditions, 37.875 ^{0}C in water spraying conditions, 41.55 ^{0}C in sea water spraying conditions and 73.3 ^{0}C in oil spraying conditions.

Results Strength Glue Slide

The Test of strength of the glue is using standards ASTM D3737. When testing the strength of the glue, the specimen is placed in the die / mold that have been designed according to the standard ASTM D905. ASTM D905 is a reference to lock the brake pads when the shear strength testing.

Table 3 Research Strength Glue Slide

No	Brake Pads	Force *F* (N)	Area *A* (m^2)	Strength Slide σ (N/m^2)
1	Fly ash	800	323.7×10^{-6}	2.471×10^{6}
2	Honda Genuine Parts	1150	323.7×10^{-6}	3.553×10^{6}

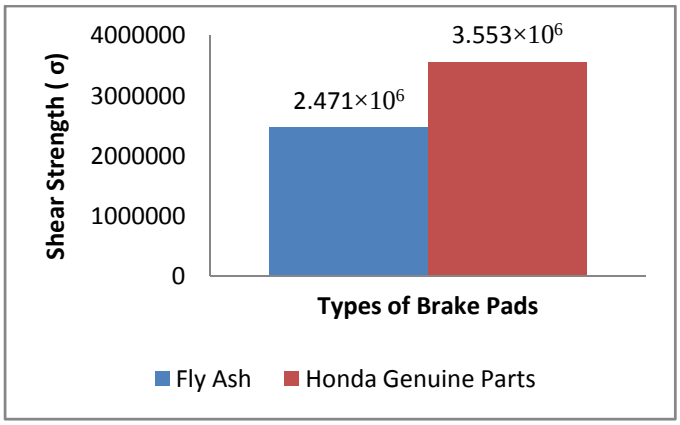


Figure 17 The Relationship Between Graph Results Type Brake Pads Slide Against Strength Glue.

This test will determine the viscosity of resistance to shear loads that supplied Fly Ash brake pads with Honda Genuine Parts brake pads for comparison.

From the test results and the calculation of shear strength indicates that the brake pads Fly Ash not better than the Honda Genuine Parts brake. This is evidenced from the results of testing the shear strength of Honda Genuine Parts brake at 3.552×10^6 (N/m^2) while the brake Fly Ash at 2.471×10^6 (N/m^2).

CONCLUSION

Based on the results of research that were conducted, we can take some of the conclusions that can be discussed and finally this study it can be concluded:

1. Fly ash can be used as a substitute for asbestos in the manufacture of brake pads. This is evidenced by the results of testing friction coefficient is given effect by spraying water, sea water, and the oil has a value greater than the friction coefficient brake pads Honda Genuine Parts.

2. From the research conducted, it can be seen that for the overall temperature of Fly Ash brake pads better than Honda Genuine Parts brake pads.

3. For the compressive strength test results brake pads Fly Ash by using glue Dextone epoxy and hardener declared unsafe if used in severe braking conditions, because damage to the bonding connection. As for gluing Honda Genuine Parts brake pads declared safe if used under conditions of heavy braking and light weight.

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